A New Species of *Melita* (Amphipoda:Gammaridae) from the Marshall Islands, Micronesia[1]

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DURING THE SUMMERS of 1968 and 1969, the author collected and studied amphipods from intertidal and subtidal lagoon habitats of three atolls (Eniwetok, Kwajalein, and Majuro) in the Marshall Islands, Micronesia. Particular emphasis was placed on collecting from calcareous sands and gravels, since most workers to date have reported on the more abundant epifaunal species (Schellenberg, 1938; Barnard, 1965). In addition, efforts were made to collect complete series of life history stages, and to study morphological variations, behavior, and general ecology of the more abundant species.

One of the most abundant and ubiquitous species from the three atolls proved to be a new species of *Melita,* also a new generic record for Micronesia. Although the species is not strictly infaunal, numerous specimens were collected from coarse intertidal sands and gravels under and near beach and coral rocks, a similar microhabitat previously reported for *M. sulca* from California (Barnard, 1969). As far as I can determine, this interesting new species is the smallest known for the genus *Melita* with the exception of two brackish-water species currently being described (Bousfield, personal communication).

The length measurement reported is the distance from the anterior margin of the head to the tip of the telson when the specimen was stretched out. Animals were preserved in 70 percent alcohol and glycerine unless otherwise stated.

Melita celericula new species
Figs. 1, 2

DESCRIPTION OF MALE: Holotype, 4.25 mm. Head length 10 percent longer than first 2 thoracic segments combined; lateral corners somewhat projecting and evenly rounded. Eyes oval, black pigmented. Mouth in coniform bundle from side view.

Antenna 1: peduncular article 1 deep, about 80 percent length of article 2 and bearing 3 spines on posterior surface (counting apical spine); article 3 short, about 33 percent length of article 2. Accessory flagellum 2-segmented and bearing 3 setae at apex; antennal flagellum with 14, 21 articles (left and right). Antenna 2: shorter than antenna 1; peduncular articles 4 and 5 subequal; flagellum with 9, 9 articles, first article longest. Both antennae fringed with short setae; those of antenna 2 longest.

Upper lip: apex slightly lobed and bearing short setae. Lower lip: outer lobe slightly incised medially; inner lobe subacute. Mandible: palp moderately long, article 2 longest, article 3 with distal group of spines; incisor with 5 teeth, lacina mobilis with 2 teeth, spine row with 4 spines; molar acutely lobed with filelike surface, bearing 2 short plumose setae. Maxilla 1: inner lobe with 6 spines apically; outer lobe with 6 apical trifurcate spines; palp article 3 armed with row of 6 subapical and 8 apical spines. Maxilla 2: lobes with rounded setose apices; inner lobe shorter and narrower than outer. Maxilliped: inner lobe reaching about one-half along article 2 of palp, apex rounded, lined with 6 spines, inner margin bearing 5 spines; outer lobe wider than inner, reaching to distal end of palp article 2, inner margin and rounded apex lined with 17 spines becoming longer apically; article 3 of palp with protrusion on inner margin; article 4 conical, tipped with spine.

Gnathopod 1: posterior margin of article 5 relatively straight; article 6 is 60 percent length of article 5; palm transverse, with a deep medial notch; article 7 stout, bifurcate, closing on anterior margin or inner side of article 6. Gnathopod 2: article 6 large, palm oblique and setose, smooth and undefined by teeth or processes; article 4 acutely produced distally; article 2 anterodistal margin with long setae; article 7 curved, fitting setose depression on inside of

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article 6. Pereopods 1 and 2: article 6 subequal in length to article 5, both shorter than article 4; both pereopods sparsely setose and spinulated. Pereopods 3 to 5: relatively strongly spinose, spines on posterior margin of article 6 longest; pereopod 3 shorter than 4 and 5; pereopod 5 longest; article 6 long, about 1½ times length of article 5; article 2 broad, minutely serrate posteriorly, produced distally into a moderately deep rounded lobe. Coxal plates 1 to 4: progressively deeper, rounded ventrally and edged with very short setae. Coxal plate 7 semilunate. Branchiae saclike, present on gnathopod 2, pereopods 1 to 4, largest on pereopod 1.

Uropod 1: reaching about 25 percent along length of outer ramus of uropod 3; rami subequal, slightly shorter than peduncle, each tipped with 5 spines; inner and outer margins of rami and peduncle spinulated; outer lower margin (proximally), and inner upper margin (distally) of peduncle with a large spine; a large spine at insertion of outer ramus. Uropod 2: shorter than uropod 1; outer ramus shorter and narrower than inner; inner margin of inner ramus, upper margin of outer ramus, and outer margin of peduncle spinulated; a large spine at insertion of inner ramus; both rami tipped with 5 spines. Uropod 3: greatly elongate; outer ramus more than twice the length of peduncle and tipped with 4 spines; inner and outer margins of outer ramus with long spines, those on the inner margin longest; inner ramus short, scalelike, 3 spines on posterior margin; peduncle with scattered spines, and a group of 4 spines posteroventrally. Telson: cleft nearly to base, outer margins rounded, apices acute and set off from rest of lobe; each telson lobe bearing 3 or 4 subapical spines (2 long) with inner spines longest, one inner medial spine.

Pleon segments 1, 2: dorsally unarmed; posterolaterally minutely serrate; ventral margin widely and weakly serrate; lower posterior corner produced slightly into an upturned tooth. Pleon segment 3: dorsally serrate; posterolaterally minutely serrate; ventral margin weakly serrate and bearing 3 spinules anteriorly; lower posterior corner produced into a large upturned tooth. Pleon segment 4: bearing a moderately large dorsal tooth projecting posteriorly. Pleon segment 5: 2 dorsolateral teeth on each side, each pair of teeth astride an anterolaterally curved spine. Pleon segment 6: gently rounded posteriorly; lower posterior corner subacute.

Color: white to cream-yellow in life.

DESCRIPTION OF FEMALE: 3.75 mm. Differs from the male as follows: Antenna 1: peduncular article 1 bearing 2, 3 spines on posterior surface; article 3 proportionately larger than in male, about 40 percent length of article 2. Antennal flagellum with 17 articles. Antenna 2: flagellum with 5, 7 articles.

Gnathopod 1: subchelate; article 5 proportionately shorter, article 6 about 73 percent length of article 5; palm slightly oblique, article 7 as long as palm. Gnathopod 2: article 6 slightly longer than article 5; palm with finely serrated margin. Pereopods 3 to 5: spines on posterior margin of article 6 shorter. Coxal plates 1 to 3 each with 2 long spinules inside lower surface. Coxal plate 6 with ventrally produced, anterior, fingerlike cusp. Oostegites very slender and bearing sparse marginal setae; present on gnathopod 2, pereopods 1 to 3.

Uropod 1: reaching less than 25 percent along length of outer ramus of uropod 3. Uropod 3: only 1 or 2 spines on posterior margin of inner ramus. Telson with small spine on outer margin of 1 lobe.

HOLOTYPE—USNM 128828, male, 4.25 mm (Fig. 1).

TYPE LOCALITY: Eniwetok Atoll; north end, lagoon side of Eniwetok Islet; underside of rocks at low-tide level; June 26, 1968.

ADDITIONAL MATERIAL EXAMINED: Total of 102 individuals. North end, lagoon side of Eniwetok Islet, underside of rocks, mid-tide to below low-tide level, June 26, 1968: 9 females (6 ovigerous), 26 males, 2 juveniles, paratypes (U.S. National Museum 128829); same locality and habitat, June 28, 1968: 3 ovigerous females, 5 males; same locality and habitat, washings from coarse sand and gravel, August 9, 1968: 3 females (2 ovigerous), 2 immature females, 7 males. Eniwetok Atoll, north end, lagoon side of Runit (Yvonne) Islet, underside of rocks, between mid- and low-tide level, July 7, 1968: 3 females (2 ovigerous), 4 males. Eniwetok Atoll, northwest corner of Rigili (Leroy) Islet, underside of rocks at low-tide level, August 8, 1968: 1 ovigerous female, 1 male. Majuro Atoll,

lagoon side of Uotjaa Islet, about 15 km east of Majuro Village, underside of rocks just below low-tide level, July 25 and 26, 1968: 5 females (4 ovigerous), 6 males. Majuro Atoll, lagoon side of Ajurotake Islet, underside of rocks just above low-tide level, July 28, 1968: 8 females (5 ovigerous), 7 males. Kwajalein Atoll, lagoon shore halfway between Roi and Namur islets, underside of rocks below low-tide level, July 9, 1968: 4 ovigerous females, 6 males.

RELATIONSHIP: This species is related to four other species in the genus possessing a similar dorsal tooth and spine ornamentation of the pleon, a diagnostic character not consistently examined in the past (Barnard, 1962). Two

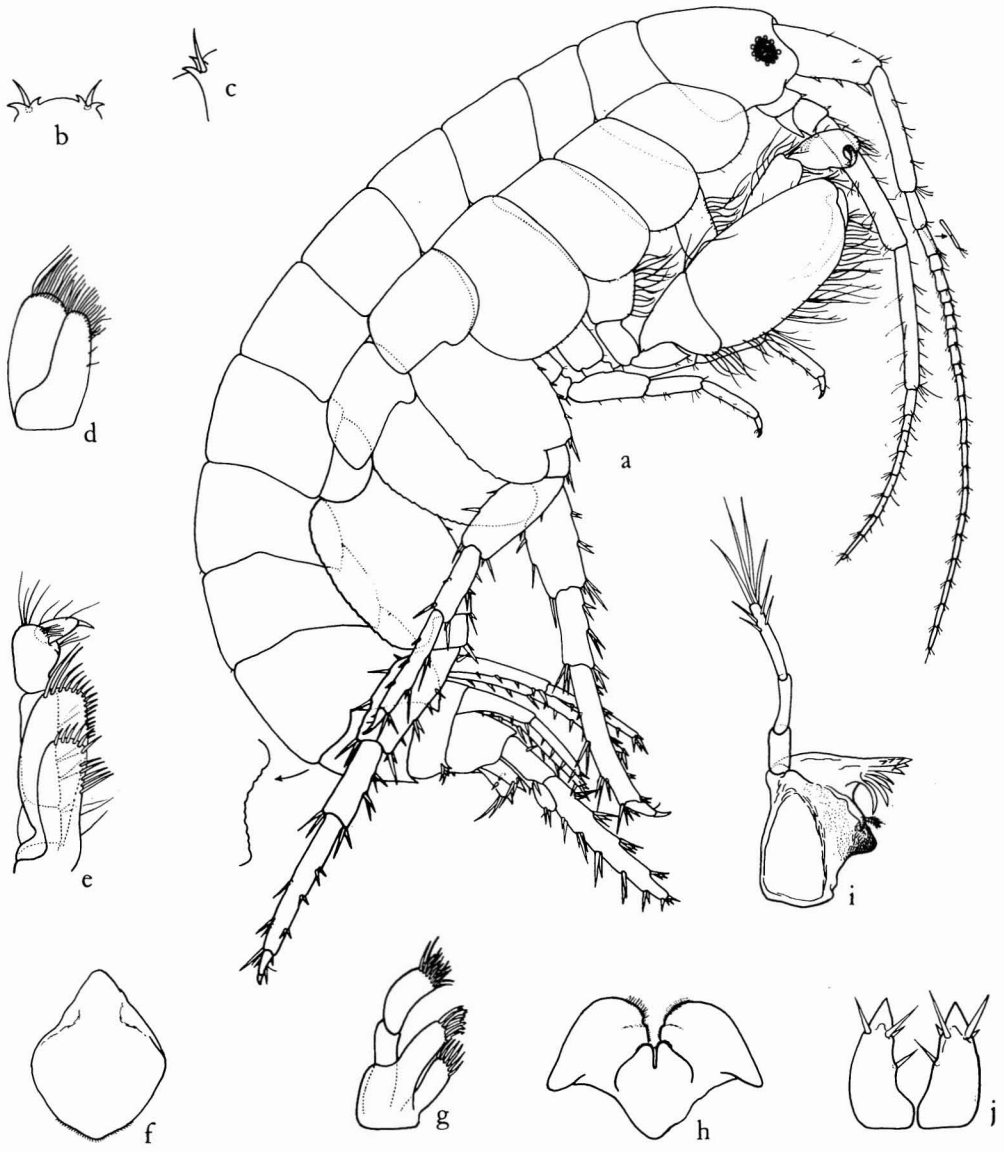

FIG. 1. Holotype of *Melita celericula* new species, USNM 128828, male, 4.25 mm. *a,* Lateral view with offset of serrations on posterodorsal margin of pleon segment 3; *b,* teeth and spines of pleon segment 5, posterior view, enlarged; *c,* teeth and spine of pleon segment 5, lateral view, enlarged; *d,* maxilla 2; *e,* maxilliped; *f,* upper lip; *g,* maxilla 1; *h,* lower lip; *i,* mandible; *j,* telson (lobes not completely cleft in life).

species, *M. desdichada* (Barnard, 1962), and *M. solada* (Barnard, 1961) differ primarily by their possession of a nonaberrant gnathopod 1, and non-"palmata" kind of gnathopod 2 in the male of the first species, and more oblique gnathopod 1 and 2 palms in the female (male unknown) of the second species. In addition, the new species differs from *M. desdichada* by shape and spination of the telson; possession of a 2-segmented rather than a 4-segmented acces-

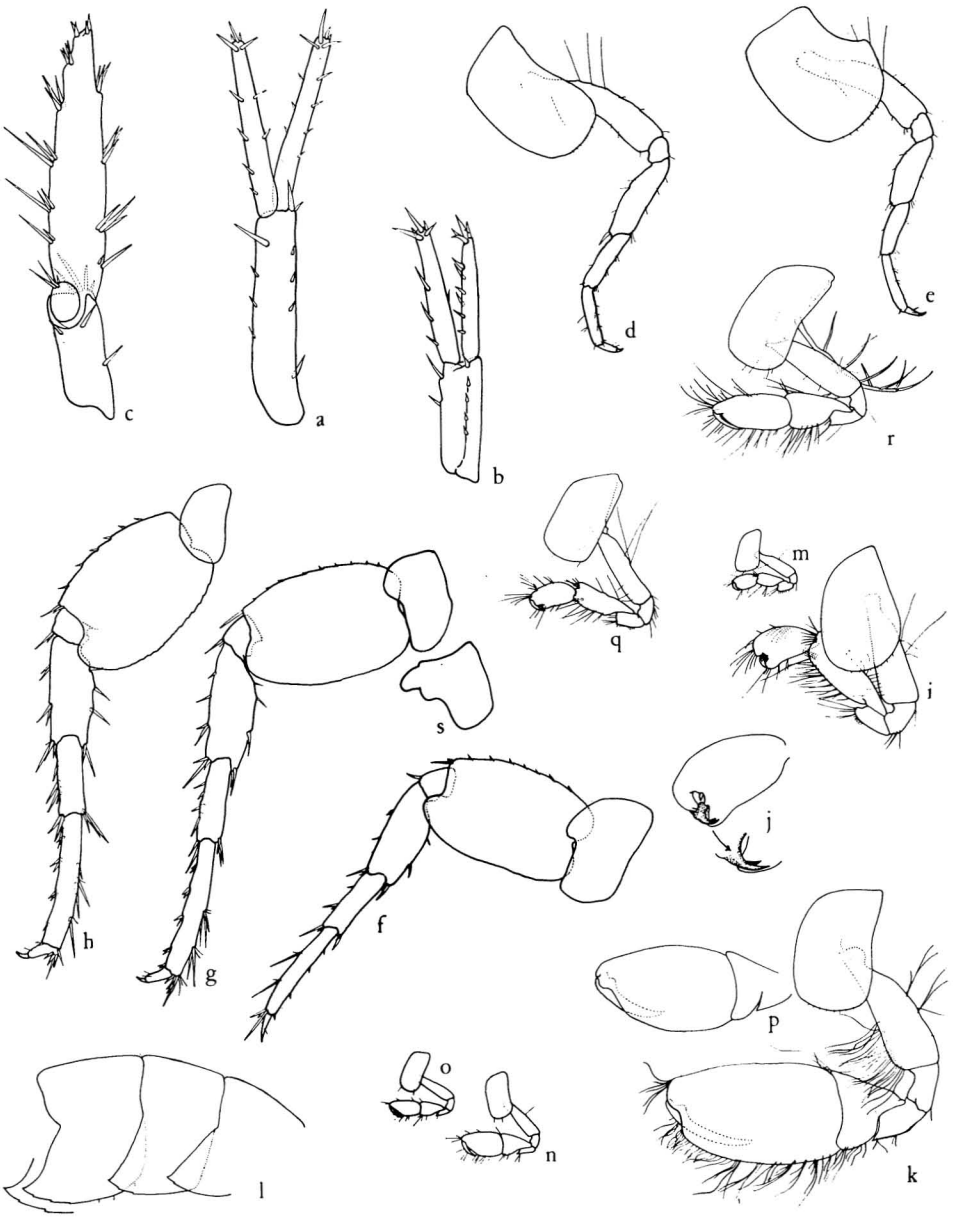

FIG. 2. *Melita celericula* new species. *a–l,* holotype, USNM 128828, male, 4.25 mm: *a, b, c,* uropods 1, 2, 3; *d, e, f, g, h,* pereopods 1, 2, 3, 4, 5; *i,* gnathopod 1; *j,* medial view, gnathopod 1, articles 6 and 7, without setation; *k,* gnathopod 2; *l,* epimeral plates 1, 2, 3, right to left. *m* through *n,* male, 2.0 mm: *m,* gnathopod 1; *n,* gnathopod 2. *o,* juvenile, 1.5 mm, gnathopod 2. *p,* male, 3.5 mm, gnathopod 2, articles 6 and 7, without setation. *q–s,* female, 3.75 mm: *q,* gnathopod 1; *r,* gnathopod 2; *s,* coxal plate 6.

sory flagellum; more ventrally produced basal article 2 of pereopods 3 to 5; stronger, and longer spination of article 6 of pereopods 3 to 5; shape of coxal plates 4 to 7; and somewhat weaker dorsal tooth on pleon segment 4. From *M. solada* the new species also differs by the stouter pereopods, including wider and more ventrally produced basal articles of pereopods 3 to 5; presence of normal eyes (atrophied in *M. solada*); relatively shorter peduncular article 2 of antenna 1 (up to four times the length of article 3 in *M. solada*); and lack of a serrated ventral margin of coxal plate 1.

Two additional species, *M. orgasmos* (Barnard, 1940), and *M. sulca* (Stout) Shoemaker (1941) (and see Barnard, 1969, Figs. 22 and 23) are similar to the new species by their possession of an aberrant gnathopod 1, and the "palmata" kind of gnathopod 2 in the male. Both of these species, however, are larger (to 12 mm for *M. sulca*), black colored, and possess a larger dorsal tooth on pleon segment 4. In addition, the new species differs from *M. sulca* by having strongly produced basal articles of pereopods 3 to 5; possession of generally 3 spines on the posterior margin of antenna 1 peduncular article 1 (rather than 5); sparser spination of the telson; less anteriorly produced dorsal lobe of gnathopod 1 palm of males; shape of coxal plates 5 and 6; and weaker upturned tooth of epimeral plate 3. From *M. orgasmos* the new species also differs by having more rounded and less produced coxal plate 1; possession of inner, medial telson spines (see Sivaprakasam, 1966, Fig. 12); relatively wide article 4 of pereopods 3 to 5 (but see Sivaprakasam, 1966); and relatively longer article 6 of female gnathopods 1 and 2, i.e., not as in *M. palmata* (Sars, 1895, Pl. 179) as discussed by Barnard (1940).

The new species also differs from the four mentioned species by the presence of dorsal serrations on pleon segment 3.

Of the species discussed above, only *M. orgasmos* occurs in the tropics. Five additional tropical species of *Melita* are known, four lacking dorsal pleonal teeth: *M. zeylanica* (Stebbing, 1904), *M. mangrovi* (Oliveira, 1953), *M. lagunae* (Oliveira, 1953), and *M. pahuwai* (Barnard, 1970); and one having dorsal teeth on pleon segments 1–5: *M. appendiculata* (Say) (= *M. fresneli*) Shoemaker (1955). Of these species, only *M. zeylanica* and *M. pahuwai* possess both an aberrant gnathopod 1 and the "palmata" kind of gnathopod 2 in the male, gnathopod characteristics that also occur in the nontropical Japanese species, *M. koreana* (Stephensen, 1944), and *M. laevidorsum* (Stephensen, 1944).

These latter four species, the *zeylanica*-group, (Barnard, 1970 and personal communication) are closely related on the basis of gnathopod morphology to *M. celericula,* despite the lack of dorsal pleonal teeth—pleonal ornamentation consisting only of 2–3 spines dorsally on each side of segment 5. From *M. zeylanica* the new species differs by having possession of a 2-segmented rather than a 3- or 4-segmented accessory flagellum; relatively longer peduncular article 2 of antenna 1; stouter and shorter maxillipedal palps; more acute mandibular lobes of the lower lip; less robust pereopods 3 to 5 in the male; and white or cream rather than greenish brown striped coloration.

M. pahuwai, from Hawaii, has a 3-segmented accessory flagellum, more robust pereopods 3 and 5, and shorter apical telson lobes. This species also has outer telson spines that are generally absent in the new species, and less produced epimeral plates 1 to 3. Male gnathopod 1 palm of *M. pahuwai* has medial spines, and a relatively shorter article 5, while male gnathopod 2 palm is deeper anteriorly.

M. koreana has a 4-segmented accessory flagellum, less produced epimeral plates 1 to 3, and lacks inner medial telson spines. Article 6 of pereopods 3 to 5 is more slender, and spines on the posterior margin of article 6 are either lacking (pereopods 4 and 5), or shorter (pereopod 3) in males as compared with *M. celericula.*

M. laevidorsum has a 4-segmented accessory flagellum, medial spines on male gnathopod 1 palm, more slender articles 2 and 6 of pereopods 3 and 5, longer antennae 1 and 2, and lacks inner medial telson spines. Lastly, uropod 3 outer ramus is more slender and longer than in *M. celericula.*

DISTRIBUTION: Eniwetok, Kwajalein, and Majuro atolls, Marshall Islands. Intertidal zone ±0.3 meters. Under rocks, and adjacent to rocks in coarse sand and gravel.

REMARKS: The specific name reflects the small size of the species and its extremely quick behavior.

MORPHOLOGICAL VARIATIONS: The following discussion is based on the indicated number of specimens from each atoll: Eniwetok, 66; Kwajalein, 10; Majuro, 26.

Antenna 1: The proportion of peduncular articles 3 to 2 varies with the size of the animales. For males, article 3 is proportionately short, attaining 33 percent the length of article 2 when animals are generally 3.5 mm in length or longer. A 4.0 mm-male from Eniwetok exhibited an even shorter article 3, i.e., 29 percent the length of article 2. In males smaller than 3.0 mm, article 3 may be 40 percent the length of article 2. Although the sample size was small, Majuro males uniformly exhibited the 33-percent figure, even animals as small as 3.0 mm. Article 3 in females is generally 40 percent the length of article 2 in the Eniwetok samples, when animals attain lengths from 2.75 to 3.0 mm. Larger Eniwetok females (3.5 mm) attain the male proportion of 33 percent. Majuro females, like males, most frequently exhibited the 33-percent figure, even animals as small as 3.0 mm. Kwajalein samples were too small to consider further for either sex.

The majority of animals from the three atolls possessed 3 spines on the posterior surface of antenna 1 peduncular article 1. However, 30 percent of Eniwetok males and females possessed 2 spines on either one or both antennae 1. There was a tendency for animals smaller than 2.5 mm to possess 2 spines on both antennae. Only 12 percent of Majuro specimens, and only 1 Kwajalein male exhibited this characteristic.

With few exceptions, the species possesses 2 articles on the accessory flagellum. One 5.0-mm male from Eniwetok possessed 3 articles on one antenna, while five animals exhibited accessory flagella bearing only 1 article including: two males from Eniwetok (2.0, 2.25 mm); one immature female from Eniwetok (2.25 mm); one ovigerous female from Kwajalein (2.75 mm); and one juvenile from Eniwetok (1.5 mm).

As may be observed in Table 1 below, antennae 1 and 2 are generally longer in males than they are in females. Broken antennae were not included in the calculations. There were no significant differences in antennal length among animals from the three atolls.

Gnathopod 1: The male palm exhibits variation with life stage. Thus, article 6 changes from normal shape in small males to the aberrant adult form (Fig. 2 *i, m*). Variation was also observed in the projection of the anteroventral lobe of article 4; in the holotype this projection was considerable.

Gnathopod 2: the relative size of the male palm increases and becomes deeper anteriorly in larger males (Fig. 2 *k, n, o, p*). The size of males attaining this deeper palm is also variable, evidenced by its presence in a 3.25-mm male from Eniwetok. All males exhibited right and left gnathopods of equal size except for a 4.25-mm animal from Eniwetok whose right appendage was larger than the left.

Pereopod 3: Approximately 33 percent of all female specimens exhibited spination on article 6 as illustrated for the male holotype. Two-thirds of the females, however, had 1 spine group much shorter on the posterior margin of article 6.

Coxal plates 1, 2: In smaller animals (<2.25 mm), the plates are less rounded ventrally (Fig. 2 *m, n, o*).

TABLE 1

ANTENNAL LENGTH IN *Melita celericula* NEW SPECIES

	MALES			FEMALES		
	NO. OF ANTENNAE MEASURED	NO. OF ANTENNAL ARTICLES		NO. OF ANTENNAE MEASURED	NO. OF ANTENNAL ARTICLES	
		RANGE	AVERAGE		RANGE	AVERAGE
Antenna 1	87	6–22	16.3 ± 3.3	47	10–19	14.2 ± 2.2
Antenna 2	107	4–9	7.2 ± 1.2	53	4–9	6.5 ± 1.0

NOTE: Length expressed as number of antennal articles.

Coxal plates 1 to 3, females: The number of spinules inside the coxal plates varies, more spinules being present in larger females. Increase in spinule number (maximum of 3 per plate) is most apparent on coxal plates 1 and 3; plate 2 generally bears 1, and, rarely, 0 or 2 spinules.

Telson: The 3.75 mm-female described above was the only female observed with a spine on the outer margin of the telson. Likewise, no Eniwetok male exhibited this characteristic. On the other hand, 37 percent of males from Majuro and Kwajalein exhibited either one ($n = 3$) or both ($n = 4$) lobes of the telson with an outer spine.

Pleon segments: Variation was observed in the degree of upturning of the tooth and serration at the lower posterior corner of segment 3 (Fig. 2). Dorsal ornamentation of pleon segments 4 and 5 is observable in animals as small as 1.5 mm.

SIZE: Sampling technique was not efficient enough to adequately reflect relative abundance of small and large animals. Consequently, average sizes of animals from the three atolls are not meaningful. Size ranges for identifiable males and females were 1.5 to 5.0 mm and 2.0 to 4.0 mm, respectively. For the summer months at least, males are generally larger than females. Females may reach 2.25 mm and lack setae on the oostegites. It is not known at what size males mature. Reproductive biology of females is discussed below.

Eleven juvenile animals with lengths 1.0 to 1.75 mm were recovered from coarse sand and gravel samples. Since the large majority of broods carried by females at this time were still early-stage eggs, these animals are probably juveniles that left the brood pouch at an earlier time.

REPRODUCTIVE BIOLOGY: Fifty *M. celericula* were collected from the undersides of rocks near low-tide level at the type locality. The animals were divided up into six separate compartments of a covered plastic box containing seawater and detritus from their habitat. Animals were held for 18 days in the dark at laboratory temperatures ranging from 28° to 33° C. Seawater, detritus, and pieces of algae were renewed every 5 days.

Two and one-half hours after laboratory holding began, three pairs were noted in precopula. During the ensuing 18 days, a total of 14 pairs were noted. Periodic observations of all animals were made two or three times per day, and estimates were made of time in precopula. Since observations consisted of seeing animals in precopula during the entire 18-day period, interspersed by periods when no animals were seen in precopula, and since ovigerous females were also observed, I assume that my estimate is of maximum time of precopula leading to successful mating. Times ranged from 2.5 to 16.0 hours, with an average of 11.5 hours.

During the period June 26 through August 9, 1968, 73 percent of the females collected in the field carried a brood. Females were found as small as 2.5 mm at first maturity (Eniwetok, Kwajalein); and as large as 4.0 mm (an ovigerous female from Majuro).

As in many amphipods, the number of eggs in a brood depends on female size. Brood sizes ranged from 1 to 10, averaging 3.4 ± 2.1 ($n = 27$). A selected number of eggs from the three atolls were measured and were found to average 0.39 ± 0.02 mm and 0.25 ± 0.02 mm ($n = 52$), for length and width, respectively. There were no significant differences in egg sizes among females from the three atolls.

BEHAVIOR: Reference has already been made to the extremely quick movements of the species. During collecting, when rocks were overturned, it was difficult to obtain more than a fraction of individuals present; the animals either entered the water or small interstices in rocks. Similar behavior was noted for animals in coarse sand and gravel, although collection here was easier.

Animals held in the laboratory tended to group on coarse particles of sand or detritus. When observed, all animals were very active, frequently feeding. Animals were observed feeding on detrital particles, fecal pellets, the algae *Valonia,* and small living *Melita celericula.* After one small *Acetabularia* was added to each compartment of the holding tray, one animal was observed chewing on a stalk. After 1 week, two complete *Acetabularia* plants had been consumed.

ECOLOGY: *Melita celericula* habitats are characterized by coral and beach rock, coarse sand,

and gravel. Fine calcareous mud was also abundant near low-tide level, particularly at the Kwajalein and Majuro habitats. A considerable variety of microhabitats is also available to the species in the lagoon reef and tide-pool zone (Wiens, 1962), an area containing boulders, pebbles, and depressions filled with fine sand. Temperatures at 2.54 cm deep in gravel, or under rocks lying on moist substrata, ranged from 29° to 33° C during midday in July at Eniwetok.

At the Eniwetok type locality, a transect was made from high- to low-tide level on July 30, 1969. Slope of the beach and true heights above mean low water were determined by the method of Emery (1960). The transect ran from +1.14 meters to +0.16 meters over a baseline distance of 24.4 meters. Duplicate 0.06 m^2 samples of the upper 2.54 cm of coarse sand and gravel were removed from four beach levels and preserved with 5 percent formalin. Animals were sorted from this material under a dissecting microscope. Densities of amphipods are reported as means of numbers from duplicate sample pairs. Several nonquantitative samples were also taken from small pools and seeps.

M. celericula occurred in beach substrata samples from tidal heights of 0.19 to 0.34 meters above mean low water (mean tidal level at Eniwetok is equal to 0.79 meters). Over tidal heights 0.19 to 0.22 meters, the species averaged 104.2 individuals per square meter, including juveniles (predominant), immature and ovigerous females, and males as large as 3.75 mm. Other associated fauna included tanaids, valviferan isopods, and juvenile amphipods of the genera *Ampithoe* and *Gammaropsis* (Barnard, 1969).

Nine amphipod species were found associated with *M. celericula* on the undersides of rocks at the three atolls: *Elasmopus* sp., *Maera* sp., *Gammaropsis pacificus, G. digitatus, Ampithoe ramondi, Cymadusa brevidactyla, Paragrubia vorax, Lembos* sp., and *L. bryopsis. Cymadusa brevidactyla* was found at three atolls, *Elasmopus* sp. at Eniwetok and Majuro, other species at one of the atolls only. These nine amphipod species and *M. celericula* are sharply demarcated from higher shore talitrid amphipods in the genera *Hyale* and *Allorchestes* that are abundant above the 0.68-meter tide level at the type locality.

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